3. GaAsからの光電子

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1. Introduction

This is a preliminary study to produce polarized electrons. An ensemble of electrons is said to be polarized if the electron spins have a preferential orientation so that there exists a direction for which the two possible spin states are not equally populated.

There are many reasons for the interest in polarized electrons. One essential reason is that in physical investigations one endeavors to difine as exactly as possible the initial and/or final states of the systems being considered. In the investigation of the large number of spin-dependent processes that occur in physics it is helpful to have electrons available in well-defined spin states.

Among many different ways for producing polarized electrons, the method to obtain photoelectrons from GaAs single crystal is the most efficient.

2. Photoemission of spin polarized electrons.

A key factor in obtaining polarized electrons is the spin-orbit splitting of the valence bands of GaAs which is shown in Fig.1. At the Γ point (k=0), p band is split into $P_{3/2}$ and $P_{1/2}$ levels, and the latter is located 0.34eV lower in energy. The origin of the spin polarization can be understood by considering the transitions from the m_j sublevels shown on the right-hand side of Fig.1. For circularly polarized light, the optical selection rules require that $\Delta m_j = +1$ for σ^+ light (solid lines in Fig.1) and $\Delta m_j = -1$ for σ^- light (dashed lines in Fig.1). The relative transition probabilities are denoted in circles in Fig.1. Thus for σ^+ light we have -50% polarization and for σ^- light +50% polarization.

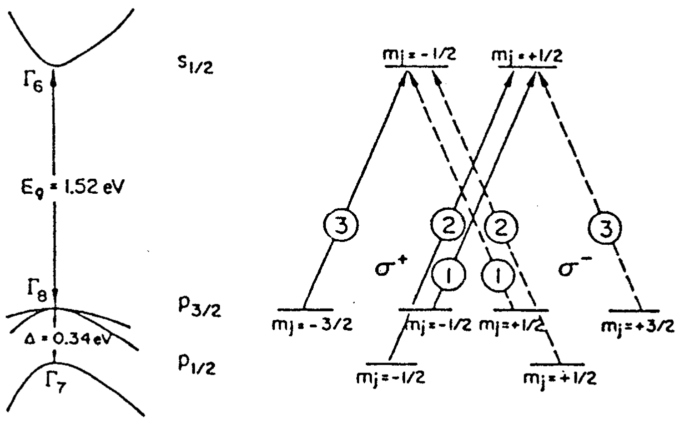

Fig.1

3. Apparatus

An overview of our apparatus is shown in Fig.2.

(1) The GaAs sample holder is positioned by a manipulator which is equipped with an electron heater to elevate the temperature of GaAs for cleaning its surface.

(2) The liquid nitrogen jacket is to cool the sample holder as soon as possible after its heat cleaning.

(3)The semi-spherical spectrometer is a retarding electric field type in order to analyze the energy of photoelectrons.

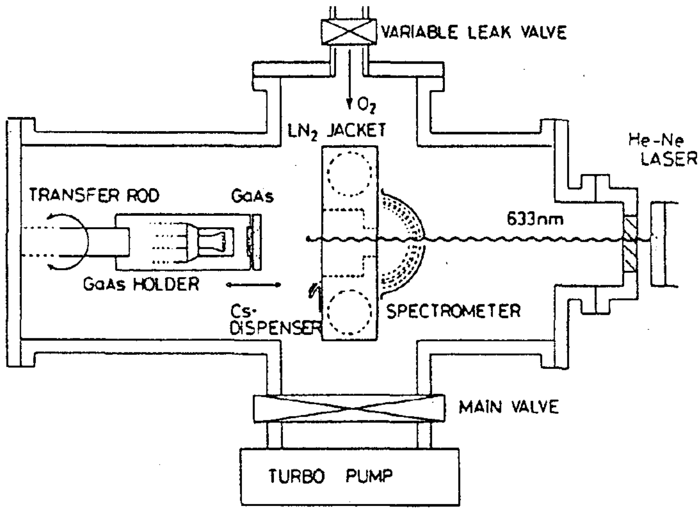

Fig. 2

4. Experimental procedures and results

After being chemically cleaned in air,the crystal surface was cleaned by heating in ultrahigh vacuum.Then the surface was activated by Cs and O_2 deposition alternatively or simultaneously. The activated surface was illuminated by a He-Ne laser with the wavelength of 633nm. The diameter of the laser beam was about 1mm and the total power was 5mW. We could get a photoelectron current of 0.4~1.5μA according to the condition of activation,as is shown in Fig.3. The intensity of the photoelectron current is quite sufficient for further investigations.

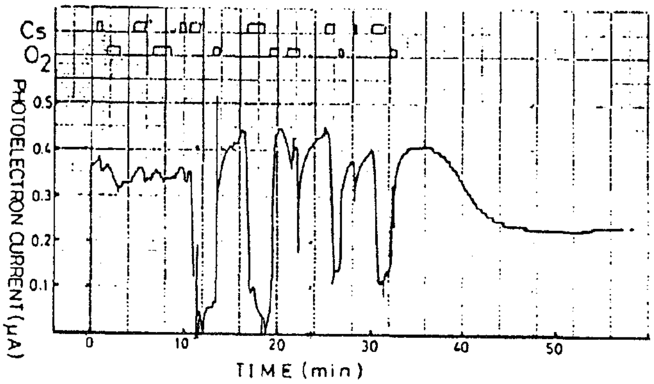

Fig.3

Reference

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